

## III B.Tech II Semester Supplementary Examinations, October/November - 2020

**POWER SEMICONDUCTOR DRIVES**

(Electrical and Electronics Engineering)

Time: 3 hours

Max. Marks: 70

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 Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory3. Answer any **THREE** Questions from **Part-B**

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**PART -A****(22 Marks)**

- 1 a) List the merits and demerits of dynamic braking? [3M]  
 b) Explain briefly the speed control techniques of dc motors? [4M]  
 c) Briefly explain about control techniques of choppers? [4M]  
 d) Variable frequency control yields high torque to current ratio during starting. Explain? [4M]  
 e) Explain the principle of slip power recovery scheme? [4M]  
 f) Briefly explain the principle of self control of synchronous motor? [3M]

**PART -B****(48 Marks)**

- 2 a) State and explain the important features of various braking methods of dc motors? [8M]  
 b) A 400 V, 750 rpm, 70 A dc shunt motor has an armature resistance of 0.3 ohms. When running under rated conditions, the motor is to be braked by plugging with armature current limited to 90A. What external resistance should be connected in series with the armature? Calculate the initial braking torque and its value when the speed has fallen to 300 rpm. [8M]
- 3 a) Describe the use of three-phase semi converter for the speed control of a D.C series motor. Illustrate your answer with appropriate waveforms and also derive the average value of output voltage and clearly draw the torque speed characteristics. [8M]  
 b) An 80 kW, 440 V, 800 rpm dc motor is operating at 600 rpm developing 75% rated torque is controlled by 3 Phase 6 pulse thyristor converter. If the back emf at rated speed is 410 V, find the firing angle of the converter. The input to the converter is 3 phase, 415 V, 50 Hz ac supply. [8M]
- 4 a) Explain the operation of single quadrant chopper fed separately excited dc motor which gives forward braking operation with the help of necessary waveforms? [8M]  
 b) A 230 V, 1200 rpm, 15 A separately excited motor has an armature resistance of 1.2  $\Omega$ . The motor is operated under dynamic braking with chopper control. Braking resistance has a value of 20  $\Omega$ . [8M]  
 i) Calculate the duty ratio of chopper for motor speed of 1000 rpm and braking torque equal to 1.8 times rated motor torque  
 ii) What will be the motor speed for duty ratio of 0.4 and motor torque equal to its half the rated torque.

- 5 a) Explain the principle of varying the speed of an Induction motor by variable frequency control of stator voltage. Draw the speed torque curves for variable frequency control for motoring and braking modes. [8M]
- b) A three phase star connected, 50 Hz, 4 pole induction motor has the following parameters in ohms referred to the stator.  $R_1=R_2=0.034$ ;  $X_1=X_2 = 0.18$ . It develops rated torque at 4% slip. Determine the motor speed at rated torque and  $f= 25$  Hz. The motor is controlled with a constant V/f. [8M]
- 6 a) Why the static Kramer drive has a low range of speed control? [8M]
- b) A 3-phase, 400V, 50Hz, 4-pole, 1400 rpm, star connected wound rotor induction motor has the following parameters referred to the stator  $R_1=2\Omega$ ,  $R_2=3\Omega$ ,  $X_1=X_2=3.5 \Omega$ . The stator to rotor turns ratio is 2. The motor speed is controlled by static Scherbius drive. The inverter is directly connected to the source. Determine  
i) the speed range of the drive when  $\alpha_{\max} = 165^\circ$   
ii) The firing angle for 0.4 times the rated motor torque and speed of 1200 rpm. [8M]
- 7 What are the open-loop and closed loop methods of speed control of a synchronous motor using VSI? Explain. [16M]

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**PART -A****(22 Marks)**

- 1 a) List the differences between Plugging and regenerative braking methods. [4M]
- b) Mark the four quadrant operations of the drive on speed-torque plane. [4M]
- c) Draw and explain the speed- torque characteristics of dc motor controlled by two quadrant type **C** chopper. [3M]
- d) Briefly explain the V/f control of induction motor. [4M]
- e) List the advantages and disadvantages of static rotor resistance control of IM. [4M]
- f) When operating in true synchronous mode, why the frequency must be changed in small steps? [3M]

**PART -B****(48 Marks)**

- 2 a) Explain the four quadrant operation of a drive using hoist control as an example. [8M]
- b) Calculate the resistance to be connected across a DC series motor used in a crane, when the supply is cut off and dynamic braking is applied to limit the speed to 500 rpm, if the descending load exerts a constant load torque of 200 N-m. The magnetization curve of the motor running at 750 rpm is a straight line given by  $E_g = (5.7 I_a + 228.6) \text{ V}$ , between  $I_a = 30 \text{ A}$  and  $50 \text{ A}$ . The total resistance including the series field resistance is  $1.1 \Omega$  [8M]
- 3 a) Explain the operation of a separately excited dc motor using three phase fully controlled rectifier. Derive the relation between speed and torque and draw the corresponding characteristics. [8M]
- b) The speed of a separately excited dc motor is controlled by means of a 3 phase full converter from a 3 phase 415 V, 50 Hz supply. The motor constants are inductance 10 mH, resistance  $0.9 \Omega$  and armature constant  $1.5 \text{ V/rad/s}$ . Calculate speed of the motor at a torque of 60 Nm when the converter is fired at  $55^\circ$ . Neglect losses in the converter. [8M]
- 4 a) Explain the operation of two quadrant chopper fed separately excited DC motor which gives forward motoring and forward braking operation and also draw current and voltage waveforms for continuous current operation. [8M]
- b) A 220 V, 20 A, 1000 rpm separately excited dc motor having an armature resistance of  $2 \Omega$  is controlled by a chopper. The chopping frequency is 500 Hz and the input voltage is 230 V. Calculate the duty ratio for a motor torque of 1.25 times rated torque at 600 rpm. [8M]

- 5 a) Explain variable frequency control of induction motor to obtain speeds below and above base speed. Derive the necessary equations. [8M]
- b) Describe the torque–speed characteristics of Induction motor with below and above base speed when using v/f control. [8M]
- 6 a) Explain the operation of three phase slip ring induction motor drive when static Kramer scheme is employed, with the help of circuit diagram. Draw the speed-torque characteristics. [8M]
- b) A 3 Phase, 420 V, 50 Hz, star connected Induction motor has the following constants referred to the stator.  $R_s = 2.95 \Omega$ ,  $R'_r = 2.08 \Omega$ ,  $X_s = 6.82 \Omega$ ,  $X'_r = 4.11\Omega$  per phase. The motor draws a current of 6.7 A at no load and controlled by rotor resistance control. The resistance  $R_e$  has been controlled by chopper. Find the value of  $R_e$  to get a speed range of 1500 to 500 rpm, assuming a turns ratio of two between stator and rotor. The torque and speed of the load are related by  $T \propto N$ . Determine the characteristics giving the speed Vs time ratio of the chopper. [8M]
- 7 a) How is the output voltage of a VSI improved by PWM techniques? Explain how we will use this converter for speed control of a synchronous motor? [8M]
- b) Discuss various methods of speed control of synchronous motors in detail. [8M]

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